

Great Lakes Environmental Research Laboratory (GLERL)

RESEARCH REVIEW TEAM DATA REQUEST

Please provide a brief history and mission of your laboratory.

History

The Great Lakes Environmental Research Laboratory (GLERL), located in Ann Arbor, Michigan, is a U.S. Department of Commerce (DOC) facility operated by the National Oceanic and Atmospheric Administration (NOAA), through the Office of Oceanic and Atmospheric Research (OAR).

GLERL was officially created within NOAA on April 25, 1974 to provide a focus for federal research on the Great Lakes, America's fourth coast. The original GLERL was formed by merging staff from the Limnology and Computer Divisions of the Lake Survey Center of the U.S. Army Corps of Engineers with the staff of the International Field Year for the Great Lakes (IFYGL) Office. The laboratory opened in Ann Arbor, Michigan in August 1974.

By 1980 the laboratory had expanded to include a major research effort on the cycling of sediment particles and associated toxic organics, which were recognized in the Great Lakes Quality Agreement as a major environmental problem of the lakes. GLERL scientists led some of the early work in identifying and evaluating processes affecting the deposition and cycling of contaminants in the lakes and showed that the sediment zone is a major repository for contaminants and also a major source for recycling contaminants to the water column.

GLERL staff is encouraged to develop cooperative research projects with other agencies focused on specific major environmental issues in keeping with NOAA's mission and goals. The water resources research area was expanded to include the impacts of climate change on the Great Lakes, which has led to GLERL's participation in the national Water Resources Forecasting (WARFS) Program. GLERL's scientific expertise on the movement and cycling of sediment particles, and circulation measurements and modeling, has led to several large joint research programs with the U.S. Environmental Protection Agency (USEPA) to develop contaminant mass balance models for selected areas: the Upper Great Lakes connecting channels, Green Bay, and most recently, Lake Michigan.

In 1989 the ecosystem dynamics component of GLERL added a small research project on nonindigenous species. Research started with the ecosystem impacts of *Bythotrephes*, the "spiny water flea" which had spread through most of the Great Lakes. However, with the discovery of zebra mussels (*Dreissena polymorpha*) in Lake St. Clair, and the passage of the Nonindigenous Aquatic Nuisance Act of 1990, GLERL was tasked with developing a major program (now the Center) on nonindigenous species, focusing on the ecosystem and environmental effects of the zebra mussel.

The 1990's have been a period of shifting resources and focusing of efforts on critical environmental problems of Great Lakes, national, or international importance, paralleled by identification of customers and their needs and interests. Today, GLERL is actively involved in research on nonindigenous species, specifically the zebra mussel in the Great Lakes, the impacts

of climate change on the Great Lakes and mid-U.S. water resources, the development of coastal environmental forecast systems, Great Lakes water supplies, water level forecasting and regulation, the use and dissemination of satellite imagery for environmental products development, the factors that affect and determine the bioavailability of toxic organic chemicals, environmental reconstruction (retrospective analysis) from sediment core records, ecosystem modeling, development of Great Lakes Observing Systems, foodwebs and fishes and work has been expanded to other coastal regions including the Chesapeake Bay.

'GLERL is a preeminent world-class and multidisciplinary environmental research laboratory that provides a solid scientific foundation and leadership on Great Lakes and marine coastal environmental issues and that offers the highest quality understanding, information, and services necessary for sustainable healthy coast and safe Great Lakes and Coastal Environments.'

Since its inception, GLERL has been staffed with a wide array of scientific disciplines and expertise, enabling it to take a unique ecosystem research focus. The research focus has evolved from an issues oriented disciplinary approach to *a multidisciplinary ecosystem approach*. This multidisciplinary approach has produced valuable insight into underlying physical, chemical and biological processes in the lakes and how they affect ecosystem dynamics. While GLERL has been highly successful in studying and explaining Great Lakes and coastal ecosystem dynamics, GLERL has recently taken another bold step forward to develop the capability to predict where such ecosystems might be headed in the immediate and long-term. Such ecosystem forecasts will give resource managers and policy makers an early warning on emerging changes and threats and allow them to take pre-emptive measures to protect ecosystem integrity, life and property and economic well-being.

GLERL's Mission Statement

The Great Lakes Environmental Research Laboratory (GLERL) conducts high-quality research and provides scientific leadership on important issues in both Great Lakes and marine coastal environments leading to new knowledge, tools, approaches, awareness and service.

Mission Goals

- 1.) To expand and improve scientific knowledge of aquatic ecosystems, and processes within the Great Lakes and marine coastal environments.
- 2.) To develop new tools, approaches, and concepts for improved modeling, predictions and management of issues within the Great Lakes and coastal environments.
- 3.) To deliver services and expert information to the scientific, regulatory, and coastal-user communities.
- 4.) To provide the general public with information and services to enhance public awareness, understanding and safety.
- 5.) To lead and coordinate multi-institutional scientific program development throughout the Great Lakes and coastal aquatic communities.

Please provide a listing of major customers of the laboratory with a one-sentence description of what is being done for them.

FEDERAL:

- *USGS Science Center*—GLERL has worked closely with the USGS over its 30-year history on fish related research. USGS Science Center has the NMFS responsibility in the Great Lakes. GLERL's close collaboration directly aids the USGS in their fish stocking decisions and habitat restoration projects.
- *EPA (LLRN/GLNPO)*—GLERL participated extensively in The **Lake Michigan Mass Balance Study**. This study, co-sponsored by the EPA, measured PCBs, mercury, trans-nonachlor, and atrazine in rivers, the atmosphere, sediments, lake water, and the food chain. A mathematical model will predict what effect reducing pollution will have on the lake, and its large fish (lake trout and coho salmon). This Study is one of many EPA activities that GLERL has conducted for and with over its 30-year history.
- *U.S. Coast Guard*—GLERL works closely with the Coast Guard and provides them with our Great Lakes Forecast System to aid in Search and Rescue. Additionally, GLERL works with the Coast Guard on Invasive Species introduction through Ballast waters.
- *U.S. Army Corps of Engineers*—GLERL is Congressionally mandated to provide the U.S. Army Corps of Engineers with water level forecasts models, which they are mandated to publish to the Great Lakes Basin. These models are constantly being improved with State-of-the-art Research by GLERL.
- *NOS/COP*—GLERL's involvement with COP has been extensive; a recent example is a 5-year program sponsored by the *NOAA-Coastal Ocean Program* and *National Science Foundation* on the impact of episodic events on episodic sediment resuspension and constituent transport and subsequent ecological effects in Lake Michigan. This study was scheduled to include three field years and two years of subsequent interpretation and product development (1998 - 2003).
- *NOS--* Develop Monitoring protocols and standards to be applied to all coastal restoration projects funded under the Estuary Restoration Act.
- *NOS Sanctuary*—GLERL provides housing for the Regional Sanctuary Coordinator and a research vessel and diver for the Thunder Bay Sanctuary.
- *NWS* —Products of GLERL's Great Lakes Forecasting System (GLCFS) are being disseminated from GLERL to NWS forecast offices through AWIPS (the NWS advanced weather information processing system). Presently, the transfer process to NOAA operational units (NCEP and NOS CO-OPS) is in progress.
- *NESDIS*—Coast Watch is a nationwide National Oceanic and Atmospheric Administration (NOAA) program within which the Great Lakes Environmental Research Laboratory (GLERL) functions as the Great Lakes regional node. As part of the CoastWatch SAR Implementation Team, GLERL, along with the Jet Propulsion Laboratory (**JPL**), **NESDIS**, the **National Ice**

Center, and the **National Weather Service**, is investigating, developing, and demonstrating the use of synthetic aperture radar (SAR) and scatterometer imagery for future products.

- *U.S.G.S. Water Survey in Michigan*—GLERL provides hydrologic and geo-hydrologic research for various studies in the Great Lakes Basin; one of which was a cooperative study with the Polish Government through the State Department on the groundwater flux into Lake Michigan and the Baltic Sea.
- *U.S. Department of State*-- The overall goal of this program is to cultivate a regional approach to environmental monitoring and forecasting in the Northern Adriatic Sea with Italy, Croatia and Slovenia and the National Science Foundation that will help manage coastal fisheries and tourism.
- *NASA*—GLERL has a long-standing history working closely with NASA on joint projects (Coast Watch, Great Lakes wireless observing system, etc.)
- *National Ice Center*—GLERL provided a 30-winter (1973-2002) set of composite ice charts and a multi-winter statistical analysis of the climatology of the ice cover **to the National Ice Center (NIC) for operational use.**

STATE:

- *Cooperative Institute for Limnologic and Ecologic Research (CILER), CICOR*—Through these cooperative institutes, GLERL has worked closely with many universities in the Great Lakes Basin, some include: University of Michigan, Michigan State University, Grand Valley State University, Eastern Michigan University, State University of New York, Ohio State University and Woods Hole Oceanographic Institute.
- *Sea Grant (Michigan, Ohio Minnesota, New York, Indiana-Illinois, Pennsylvania)*—GLERL provides researchers (speakers) to Sea Grant for their outreach public meetings on crucial issues that affect the Great Lakes (e.g., water levels, invasive species, ice formation, etc.). Additionally for NOAA Sea Grant, GLERL develop an experimentally validated computational fluid dynamics model of flow in a typical Great Lakes bulk carrier ballast tank that can be used to study the flow dynamics and predict the efficacy of the flow-through exchange as a ballast water management and treatment practice.
- *Great Lakes Sea Grant Extension Office*-- Initiated in 2003, the Great Lakes Sea Grant Extension Office at GLERL represents a first-in-the-nation effort to connect NOAA Research to the outreach capabilities of NOAA Sea Grant. The Extension Agent at GLERL provides information based on GLERL research to Sea Grant extension agents located throughout the Great Lakes region for use in their local extension programming and provides feedback to GLERL researchers on the research needs of the coastal constituencies served by Sea Grant extension as well as conducting direct extension and outreach programming. Web products include electronic newsletters, photo galleries, seminar video archives, project information, and topical directories of GLERL publications and resources.

- *Great Lakes Commission*—GLERL works with this inter-state organization which represents Governor appointed commissioners from all eight Great Lakes states. For decades GLERL provided scientific expertise, products and services on hundreds of studies; a recent study was Habitat restoration of Lake St. Clair
- *Great Lakes Protection Fund*—GLERL provides research on both No Ballast on Board (NOBOB) and Ballast water on invasive species problem.
- *State Departments of Natural Resources (DNR)*—GLERL works closely with Michigan DNR, Ohio DNR, etc on various environmental research programs.

INTERNATIONAL:

- *Environment Canada*—GLERL works closely (daily) with Environment Canada and its associated governmental agencies, universities and local entities (Hydro Quebec, Canadian Center for Inland Waters, Ontario Hydro, etc.) in its 30-year history on Great Lakes issues: water levels, ice cover, contaminants, diversions, invasives, foodweb disruptors, etc.
- *Great Lakes Fisheries Commission*—GLERL has provided research and products over the past 30 years that allowed this international organization to protect the \$4 Billion Sports Fisheries Industry in the Great Lakes. GLERL is presently involved on three studies for the Commission.
- *International Joint Commission*—GLERL has provided research expertise to this international organization over the last 30 years on subjects concerning: 1) levels, flows and diversions; 2) contaminants; 3) fisheries; and, 4) invasives. Several researchers serves on or chairs IJC boards: 1) Great Lakes Research Managers; and, 2) Lake Ontario Level Reference Study, etc.
- *Canadian Ice Service*--GLERL provided a 30-winter (1973-2002) set of composite ice charts and a multi-winter statistical analysis of the climatology of the ice cover **to the Canadian Ice Service (CIS) for operational use.**

LOCAL:

GLERL collaborates with many local agencies, the private sector and the public; some of which are: Dunn Geosciences, ERIM, ACRES International, Philpot Engineering, Great Lakes Carriers Association, National Wildlife Federation, Navy Club, Grand Haven (Waterfront Plan), South Haven (Maritime Museum), Davis-Bessie Nuclear Power Plant, etc.

- *New York Power Authority*—uses GLERL's 6-month water level forecasts to predict the amount of hydropower they can provide for New York city (NYPA provides 1/3 of the power to New York). These predictions enables when to store water for leaner times—our models are installed at their office.

- *Davis-Bessie Nuclear Power Plant*—GLERL provided this organization with both critical information and its Great Lakes Forecast System for Lake Erie. Because of low water levels the plant's coolant pipes were not providing the plant with cooling levels needed. The Forecast system can predict when wind-driven surges will shift this critical water to other parts of the basin—allowing managers to control production levels.
- *Great Lakes Carriers Association*—Provide them with water level information for safe navigation.

Please provide a summary of research being conducted at GLERL
The Geographic Scope of GLERL's research is both Regional and International.

I. GLERL HYDRODYNAMICS AND PHYSICAL PROCESSES RESEARCH PROGRAM

This program supports research on physical processes in large lakes and the coastal ocean and their relationship to the biology, chemistry, and geochemistry of the ecosystem. This research is used to develop models to identify, forecast, and assist in managing and/or mitigating water quality and natural resource problems. Wind, waves, and thermal structure are primary determinants of water movements, mixing, and circulation in large lakes and (along with tides) in coastal ocean areas. The movement and mixing of water in natural systems affects water quality, biological community structure and productivity, and both sediment and contaminant transport, especially in nearshore areas. This research program also provides tools for more effective management of water resources: new or improved circulation and wind models and other products that assist in marine hazard prediction, emergency response, or damage prevention and reduction.

NOAA Program Areas: 1) Ecosystem Research; 2) Local Forecasts and Warnings; 3) Hydrology—Rivers, Lakes, and Floods; 4) Environmental Modeling; and, Coastal Resource Management.

Research Timeframe: Long-term

II. GLERL WATER RESOURCES RESEARCH PROGRAM

This research program develops improved Great Lakes water resource predictions, climatology, statistics for decision-making, and process studies, and develops interfaces with policy and decision-makers. There are two primary components to this research program: Water Resources Forecasting and Hydrologic Processes .

Water Resources Forecasting

Develop a system for nowcasts and 1-day-to-3-month probabilistic forecasts of water supplies, lake levels, and connecting channel flows, with consideration of basin moisture storage and lake heat storage variables, to produce useful and timely forecast products and capabilities.

Hydrologic Processes

Adapt or develop models that couple atmospheric and hydrological processes to gain predictive capability for rainfall-runoff, evapotranspiration, moisture storage, lake surface flux, thermal structure, heat storage, and other processes relating to the hydrologic cycle, and apply these models to water resources forecasting and climate change assessments.

NOAA Program Areas: 1) Ecosystem Research; 2) Hydrology—Rivers, Lakes, and Floods; 3) Environmental Modeling; and, 4) Coastal Resource Management

Research Timeframe: Long-term

III. GLERL CLIMATE CHANGE and VARIABILITY PROGRAM

This research program brings together projects that examine the potential effects of climate change on the Great Lakes water resources and ecosystem.

Conduct studies to identify and improve our understanding of the impacts of climate change and variability on socio-economic frameworks and ecosystem structure and function, including those through intermediate effects such as changes in the water supply of the Great Lakes Basin. This will aid in improving planning for regional adaptation strategies. Analyze and model climate variables over the last 100 years and projections in the future to identify the implications to regional water resources.

NOAA Program Areas: 1) Ecosystem Research; 2) Climate Assessment and Predictions; 3) Hydrology—Rivers, Lakes, and Floods; and, 4) Environmental Modeling

Research Timeframe: Long-term

IV. GLERL ECOSYSTEM DYNAMICS RESEARCH PROGRAM

This research program focuses primarily on key components of the Great Lakes foodweb and the links between physical, chemical, and biological processes that impact important processes in ecosystem function. Although long-term trends in key components are examined, life history studies and process research are emphasized so that GLERL's expertise can be applied to problems in a variety of ecosystems that are geographically and biologically diverse.

Improve our knowledge and understanding of food web processes and dynamics, and their relationship to environmental quality and living resources in Great Lakes and coastal marine ecosystems. Apply this knowledge better understand the causes, effects, and solutions to problems such as eutrophication, toxic contaminants, nonindigenous species invasions, habitat modification, and climatic variations.

NOAA Program Areas: 1) Ecosystem Research; 2) Habitat Restoration; 3) Invasive Species; 4) Environmental Modeling; and, 5) Coastal Resource Management.

Research Timeframe: Long-term

V. GLERL EPISODIC EVENTS RESEARCH PROGRAM

Episodic Events-- storms, runoff-events, down-welling, upwelling, lake ice cover, and thermal bar formation - play a very important role in processes that affect the structure and function of nearshore ecosystems. The episodic resuspension and subsequent transport of surface sediments profoundly influences biogeochemical processes in coastal ecosystems. The magnitude and episodic nature of these processes in the Great Lakes has been poorly described in the past from a few point measurements or as the residual term in mass balance models. Determining what processes control the inshore to offshore transport of biological, chemical, and geological materials in the coastal margins of the Great Lakes and developing strategies to quantify and predict the impacts of these events are some of the goals of this research program.

NOAA Program Areas: 1) Ecosystem Research; and, 2) Environmental Modeling

Research Timeframe: Medium-Term

VI. AQUATIC CONTAMINANTS RESEARCH

The Aquatic Contaminants Research Program combines process studies and mathematical modeling focused on toxic organic contaminants to increase our understanding of the dynamics and effects of pollutants in the ecosystem.

The purpose of this research is to: 1) determine processes that govern contaminant fluxes into and out of sediments, that mix contaminants within sediments, and that control the transfer of contaminants from sediments into the food chain; 2) develop methods for assessing the extent or degree of sediment contamination and for determining bioavailability and bioaccumulation of sediment associated contaminants; and, 3) improve methods for interpreting the hazard of bioaccumulated contaminants by developing the time-dose response relationships based on accumulated body residue.

NOAA Program Areas: 1) Ecosystem Research; and, 2) Coastal Resource Management.

Research Timeframe: Long-term

VII. BIOGEOCHEMISTRY RESEARCH

The Biogeochemistry Research Program is designed to help answer questions and address issues about the ecosystem's biogeochemical response to stressors.

Employ radioactive and stable isotopes to establish geochronologies and probe major Great Lakes and coastal ecosystem processes and their alteration by anthropogenic stresses such as contamination and climatic variations, with emphasis on the carbon and nitrogen cycles, and the use of natural and fall-out radioisotopes.

NOAA Program Areas: 1) Ecosystem Research; and, 2) Coastal Resource Management.

Research Timeframe: Long-term

VIII. GLERL'S INVASIVE SPECIES CONTROL, ASSESSMENT AND IMPACTS PROGRAM

The Great Lakes basin is the aquatic gateway to the heartland of America and a hot spot for aquatic invasive species (AIS) introductions that can reach other sections of the U.S. The earliest recorded aquatic species invasion in the Great Lakes was the sea lamprey, first entering the Great Lakes from the Atlantic Ocean via the Erie Canal during the 1820s. Based on scientific documentation, there are at least 162 AIS in the Great Lakes as of 2001 and twelve of these appear to have entered since 1990. Introduced species are now a significant component of most trophic levels in the Great Lakes.

GLERL's research on invasive species targets two key issues:

1. Prevention of new invasive species introductions
2. Understanding the biology and ecological impacts of nonindigenous species in the Great Lakes

GLERL also houses NOAA's newly established [National Center for Research on Aquatic Invasive Species](#) at its Ann Arbor facility. The center will allow [NOAA](#) to more effectively organize and coordinate its aquatic invasive species research efforts while assuring that NOAA resources are focused on priority problems nationwide.

NOAA Program Areas: 1) Ecosystem Research; 2) Habitat Restoration; 3) Invasive Species; 4) Environmental Modeling; and, 5) Coastal Resource Management.

Research Timeframe: Long-term

IX. GLERL INTEGRATED LONG-TERM MONITORING AND ASSESSMENT PROGRAM

There are two primary components to this program:
[Long-Term Monitoring](#) and [CoastWatch](#).

A. Long-Term Monitoring

The Great Lakes ecosystem has undergone dramatic changes in food web structure and function due to recent invasions by nonindigenous species; reduced phosphorus loads, fishing pressure, resource management, and climate change. A sound monitoring and assessment capability is essential to provide knowledge of system integrity under varying degrees of environmental stress. Resource management is improved by a thorough knowledge of the health of the ecosystem and the rates at which various attributes are changing. Understanding ecological processes requires long-term study. Only through monitoring of physical, chemical, and biological processes can patterns and periodicity of rare events begin to emerge and unacceptable changes in the environment be detected. Monitoring at multiple spatial and temporal scales is an essential component of GLERL's overall research program.

B. CoastWatch

CoastWatch is a NOAA-wide program designed to facilitate the distribution and access to NOAA satellite products relevant to the coastal environment. Satellite and *in situ* data and products are received and/or developed at eight regional CoastWatch nodes throughout the coastal United States and Great Lakes and are distributed via the Internet to Federal, state, and local agencies and academic institutions for environmental monitoring, management, and supporting research. CoastWatch directly supports agency statutory responsibilities in estuarine and marine science, living marine resource protection, and ecosystem monitoring and management.

NOAA Program Areas: 1) Ecosystem Research; 2) Habitat Restoration; 3) Invasive Species; 4) Environmental Modeling; and, 5) Coastal Resource Management.

Research Timeframe: Long-term

Please provide a listing of 3-5 major accomplishments in the last five years.

I. Establish (NOAA) National Center for Research on Aquatic Invasive Species at GLERL

Aquatic Invasive Species (AIS) are a global threat that affect the economic security, management, and beneficial uses of our coastal ecosystems. Economic losses are valued in the \$10 billion per year. NOAA has specific Congressional Mandates to lead National Research efforts on this topic. In order to maximize the benefits and effectiveness of NOAA's research investments towards understanding, preventing, responding to, and managing aquatic species invasions in U.S. coastal ecosystems, the agency established the NOAA National Center for Research on Aquatic Invasive Species in July 2003. The Center is administratively housed at the Great Lakes Environmental Research Laboratory in Ann Arbor, Michigan. The Center's broad goal is to foster, coordinate, and support aquatic invasive species research throughout NOAA, enhancing its ability to accomplish its mission and strategic goals and carry out mandated responsibilities on AIS issues.

<http://www.glerl.noaa.gov/res/Programs/ncrais/ncrais.html>

II. Implement operational mode of GLERL Coastal Forecasting System wave forecasts for the Great Lakes to NWS offices via NOAAPORT and AWIPS

Purpose: The GLCFS ([Great Lakes Coastal Forecasting System](#)) project is designed to develop and fully implement a system of computerized models that can simulate and predict the three-dimensional structure of currents, temperatures, water level fluctuations, wind waves, and sediment transport in the Great Lakes. The project integrates these models with the required observational data systems into a real-time coastal prediction system. The project makes the information developed from this system available in a useful format and in a timely fashion to [National Weather Service](#) (NWS) forecasters, coastal users and resource managers.

Customers: The results of this project are useful to all users of the Great Lakes coastal waters who require real-time information and forecasts of temperatures, currents, water levels, and waves. Physical processes have a major impact on environmental, chemical, and biological processes and influence many other types of user activities, such as water supply management, waste water management, power plant sitings, shipping, recreational and commercial boating

and fishing, shoreline erosion and redistribution of sedimentary material. Planners and managers responsible for any part of the Great Lakes ecosystem that is affected by lake circulation, such as transport of toxic material or nutrient enrichment processes, will have full access to the information provided by Great Lakes Coastal Forecast System (GLCFS) to assist them in their decision making processes.

The forecasts of lake waves, water levels, water temperatures, and currents are expected to provide NWS marine forecasters with a significant source of new information, which should lead to considerable improvements both in the accuracy and efficiency of marine forecasts for the Great Lakes.

Significance: Making Great Lakes wave and circulation forecasts available to NWS forecasters at their workstations is the culmination of a ten year research and development effort at GLERL and Ohio State University to demonstrate the feasibility of operational coastal forecasts for the Great Lakes. The Great Lakes Coastal Forecasting System has been the prototype for similar systems being developed for coastal areas and estuaries both in the US and around the world.
<http://www.glerl.noaa.gov/res/Milestone/2003/Q4/2003q4schwab.html>

*III. Discovered the disappearance of a major and fundamental component of the Great lakes food web (*Diporeia*).*

Purpose: The purpose of a 25-year research and monitoring program has been in place to quantify distributions of the important benthic species throughout Lake Michigan and assess changes that had occurred in the past 5 years. *Diporeia* is the dominant benthic macroinvertebrate and a keystone component of the food web in the offshore waters of most of the Great Lakes. GLERL has documented the unprecedented and rapid disappearance of this species in Lake Michigan. This is a crisis in the Great Lakes and ongoing research is evaluating the potential impact of this discovery on the \$4B Great Lakes sport fishery. *Diporeia* is one of the key indicators of a healthy ecosystem as defined by the International Joint Commission and the Great Lakes Water Quality Agreement. GLERL has already published an assessment of the negative impact of their disappearance on the largest commercial fishery, the whitefish.

Customers: State and federal (USFWS, Great lakes Fishery Commission) fisheries managers have the responsibility to maintain healthy, sustainable fish populations and require forecasts of how these changes will affect the fisheries. Declines in fisheries will have widespread impact on local tourism, marina operations, a \$4B sports fishery and the general public. It is GLERL's role to keep these customers informed of the latest scientific developments and forecasts.

Significance: A lakewide decline of *Diporeia* would have profound implications for the Lake Michigan web. *Diporeia* is an easily attainable, high-caloric food source. With the loss of this species, fish would need to feed on alternate food items, thereby creating competitive interactions and changing trophic transfer efficiencies within the Lake Michigan ecosystem.

<http://www.glerl.noaa.gov/res/Milestone/2001/Q3/2001q3nalepa.html>

IV. Completed major NOAA/NSF science program on cross-margin transport in the Great Lakes

In August 1997 the [NOAA-Coastal Ocean Program](#) and [National Science Foundation-Coastal Ocean Processes](#) program began a jointly funded study of the impact of episodic events on episodic sediment resuspension and constituent transport and subsequent ecological effects in Lake Michigan. This study was led by GLERL and was the largest multidisciplinary effort on the Great Lakes in three decades. It involved over 40 principal investigators and over 20 institutions. This study comprised of three field years and two years of subsequent interpretation and product development (1998 - 2003). Program components include a retrospective analysis of satellite imagery, water intakes, and other historical data, process and survey cruises, moored current meters, traps and data acquisition instruments and coupled hydrodynamic/sediment transport/ecological modeling.

Significance: The episodic resuspension and subsequent transport of surface sediments profoundly influences biogeochemical processes in coastal ecosystems. Resuspension and transport of the large inventories of nutrients and contaminants deposited over the past few decades (e.g. P, ^{137}Cs , PCBs), presently results in much greater fluxes to the water column than from all external inputs. In addition, control of biological processes can occur as a result of effects on light and substrate availability and the introduction of meroplanktonic species. The magnitude and episodic nature of these processes in the Great Lakes has been poorly described from a few point measurements or as the residual term in mass balance models. This multi-disciplinary project employed comprehensive measurement and modeling approaches to examine and compare effects of episodic physical forcing in relation to more persistent long-term (i.e., seasonal meteorological) forcing on nutrient inventories, fluxes and distributions, and on biological distributions and rate processes. The results of this proposed research improves our understanding of critical processes and support the development of a resource management-oriented information and modeling system dealing with the critical contaminant and nutrient loading issues in the Great Lakes.

http://www.glerl.noaa.gov/res/Task_rpts/eeeadie12-1.html

V. Compile and distribute digital atlas of Great Lakes ice cover

Synoptic ice chart observations for the Great Lakes began in 1960. A synoptic ice chart usually covers only a portion of one or more of the Great Lakes. Synoptic ice charts for a 20-winter base period (1960 to 1979) were digitized, and a multi-winter statistical analysis of ice concentration patterns over nine half-month periods (Dec. 16-31 to April 16-30) was published as a National Oceanic and Atmospheric Administration (NOAA) Great Lakes Ice Atlas 20-years ago.

Composite ice charts, a blend of observations from different data sources (ships, shore, air craft, and satellite) that cover the entire area of the Great Lakes for a given date, and which may contain some estimated ice cover data, were produced starting in the 1970s. A 30-winter (1973-2002) set of composite ice charts was digitized, and a multi-winter statistical analysis of the climatology of the ice cover concentration was completed. **The data and updated climatology has been made available to the National Ice Center (NIC) and Canadian Ice Service (CIS) for operational use.**

The results of this analysis are published here as an electronic NOAA Great Lakes Ice Atlas. Detailed documentation and description of analysis methods, and a discussion of the resulting products, will supplement this atlas as a series of reports.

<http://www.glerl.noaa.gov/data/ice/atlas/>

Please provide a summary of legal mandates for the work at GLERL.

33 U.S.C. § 1268 ESTABLISHMENT OF GREAT LAKES RESEARCH OFFICE

There is established within the National Oceanic and Atmospheric Administration the Great Lakes Research Office. The Research Office shall conduct, through the ***Great Lakes Environmental Research Laboratory***, the National Sea Grant College program, other Federal laboratories, and the private sector, appropriate research and monitoring activities, which address priority issues, and current needs relating to the Great Lakes.

The Research Office shall identify issues relating to the Great Lakes resources on which research is needed. The Research Office shall submit a report to Congress on such issues before the end of each fiscal year, which shall identify any changes in the Great Lakes system \2\ with respect to such issues.

16 U.S.C. § 1447B—REGIONAL MARINE RESEARCH PROGRAMS

“The **Great Lakes Research** Office authorized under section 1268(d) of title 33 shall be responsible for **research** in the **Great Lakes** region and shall be considered the **Great Lakes** counterpart to the **research** program established pursuant to this chapter.”

15 U.S.C. § 1511 COMMERCE AND TRADE

The following are hereby transferred to the Secretary of Commerce:

(e) Those functions vested in the Secretary of Defense or in any officer, employee, or organizational entity of the Department of Defense by the provision of Public Law 91-144, 83 Stat. 326, under the heading

“..... (2) the conception, planning, and conduct of basic research and development in the fields of water motion, water characteristics, water quantity, and ice and snow, and (3) the publication of data and the results of research projects in forms useful to the Corps of Engineers and the public, and the operation of a Regional Data Center for the collection, coordination, analysis, and the furnishing to interested agencies of data relating to water resources of the ***Great Lakes***.

16 U.S.C. § 4741--CONSERVATION

(1) \$1,625,000, which shall be made available from funds otherwise authorized to be appropriated if such funds are so authorized, to fund aquatic nuisance species prevention and control research under section 4722(i) of this title at the ***Great Lakes Environmental Research Laboratory*** of the National Oceanic and Atmospheric Administration, of which \$500,000 shall be made available for grants, to be competitively awarded and subject to peer review, for research relating to Lake Champlain

“(3) \$1,125,000 to fund aquatic nuisance species prevention and control research under section 4722(i) of this title at ***the Great Lakes Environmental Research Laboratory*** of the National Oceanic and Atmospheric Administration;

Executive Order 13112 INVASIVE SPECIES

“Each federal agency whose actions may affect the status of invasive species shall, to the extent practicable and permitted by law,

- 1) identify such actions;
- 2) subject to availability of appropriations, and within the Administration budgetary limits, use relevant programs and authorities to : (i) prevent the introduction of invasive species; (ii) detect and respond rapidly to and control populations of such species in a cost-effective and environmentally sound manner; (iii) monitor invasive species populations accurately and reliably; (iv) provide for restoration of native species and habitat conditions in ecosystems that have been invaded; (v) conduct research on invasive species and develop technologies to prevent introduction and provide environmentally sound control of invasive species....”

16 U.S.C. § 4722. AQUATIC NUISANCE SPECIES PROGRAM

The Assistant Secretary, in consultation with the Task Force, shall investigate and identify environmentally sound methods for preventing and reducing the dispersal of aquatic nuisance species between the Great Lakes-Saint Lawrence drainage and the Mississippi River drainage through the Chicago River Ship and Sanitary Canal, including any of those methods that could be incorporated into the operation or construction of the lock system of the Chicago River Ship and Sanitary Canal.

The *Great Lakes Environmental Research Laboratory* of the National Oceanic and Atmospheric Administration shall provide technical assistance to appropriate entities to assist in the research conducted pursuant to this subsection.

16 U.S.C. § 760e – STUDY OF MIGRATORY GAME FISH; WATERS; RESEARCH PURPOSE

“The Secretary of Commerce is directed to undertake a comprehensive continuing study of migratory marine fish of interest to recreational fishermen of the United States,...including fish which migrate through or spend part of their lives in the inshore waters of the United States. The study shall include, but not be limited to, research on migrations, identity of stocks, growth rates, mortality rates, variation in survival, environmental influences, both natural and artificial, including pollution and effects of fishing on the species for the purpose of developing wise conservation policies and constructive management activities.”

42 U.S.C. § 7412—PUBLIC HEALTH & WELFARE—POLLUTION PREVENTION AND CONTROL

“ The Administrator, in cooperation with the Under Secretary of Commerce for Oceans and Atmosphere, shall conduct a program to identify and assess the extent of atmospheric deposition of hazardous air pollutants (and in the discretion of the Administrator, other air pollutants) to the **Great Lakes**, the Chesapeake Bay, Lake Champlain and coastal waters. As part of such program, the Administrator shall—

(A) monitor the **Great Lakes**, the Chesapeake Bay, Lake Champlain and coastal waters, including monitoring of the **Great Lakes** through the monitoring network established pursuant to paragraph (2) of this subsection and designing and deploying an atmospheric monitoring network for coastal waters pursuant to paragraph (4);

- (B) investigate the sources and deposition rates of atmospheric deposition of air pollutants (and their atmospheric transformation precursors);
- (C) conduct research to develop and improve monitoring methods and to determine the relative contribution of atmospheric pollutants to total pollution loadings to the **Great Lakes**, the Chesapeake Bay, Lake Champlain, and coastal waters;”

15 U.S.C. §§ 1525, 1540—COOPERATIVE AGREEMENTS/REIMBURSEMENT TO FURTHER NOAA’S MISSION

Memorandum of Understanding between The Environmental Research Laboratories of the National Oceanic and Atmospheric Administration and the University of Michigan -- Revision of 7/11/89.

“The environmental Research Laboratories (ERL) of the National Oceanic and Atmospheric Administration (NOAA) have collaborated for a number of years with the University of Michigan and Michigan State University in limnological and environmental research. This Memorandum of understanding (MOU) between NOAA and the University of Michigan reaffirms their common interest in these research areas and provides a basis for future cooperative research efforts. 2. Improve the effectiveness of graduate-level education and expand the scientific experiences available to graduate students by providing a central vehicle for their participation in joint research programs with the **Great Lakes Environmental Research Laboratory**.2) Assist in the coordination of research accomplished in GLERL... 1) **Facilitate the establishment of joint research projects between scientists”**

15 U.S.C. § 2901—NATIONAL CLIMATE PROGRAM ACT

“(b) Formulation of United States Policy.--The President, through the Environmental Protection Agency, shall be responsible for developing and proposing to Congress a coordinated national policy on global climate change. Such policy formulation shall consider research findings of the Committee on Earth Sciences of the Federal Coordinating Council on Science and Engineering Technology, the National Academy of Sciences, the National Oceanic and Atmospheric Administration,....”

33 U.S.C. § 145—HARMFUL ALGAL BLOOM AND HYPOXIA RESEARCH AND CONTROL ACT OF 1998

“(10) the National Oceanic and Atmospheric Administration, through its ongoing **research**, education, grant, and coastal resource management programs, possesses a full range of capabilities necessary to support a near and long-term comprehensive effort to prevent, reduce, and **control** harmful algal blooms and **hypoxia**;

“(11) funding for the **research** and related programs of the National Oceanic and Atmospheric Administration will aid in improving the Nation's understanding and capabilities for addressing the human and environmental costs associated with harmful algal blooms and **hypoxia**; and...”

33 U.S.C. § 1268--NAVIGATION AND NAVIGABLE WATERS--WATER POLLUTION PREVENTION AND CONTROL--RESEARCH AND RELATED PROGRAMS

“The Congress finds that--

(A) the Great Lakes are a valuable national resource, continuously serving the people of the United States and other nations as an important source of food, fresh **water**, recreation, beauty, and enjoyment;

(B) the United States should seek to attain the goals embodied in the Great Lakes **Water Quality Agreement** of 1978, as amended by the **Water Quality Agreement** of 1987 and any other

agreements and amendments, with particular emphasis on goals related to toxic pollutants; and...”

33 U.S.C. §2326b-NAVIGATION AND NAVIGABLE WATERS--WATER RESOURCES DEVELOPMENT

“The Secretary may enter into cooperation agreements with non-Federal interests with respect to navigation projects, or other appropriate non-Federal entities, for the development of long-term management strategies for controlling sediments at such projects.”

Studies conducted at GLERL for CORPS with regards to dredging

GREAT LAKES WATER QUALITY AGREEMENT OF 1978—AMENDED 1987

International Agreement between Canada and the United States which involves restoring and enhancing water quality in the Great Lakes System

“Implementation: The Parties, in cooperation with State and Provincial Governments, shall conduct research in order to:

- a) Determine the mass transfer of pollutants between the Great Lakes basin Ecosystem components of water, sediment, air, land and biota, and the processes controlling the transfer of pollutants across the interfaces between these components in accordance with Annexes 13,14, 15, and 16;
- b) Develop load reduction models for pollutants in the Great Lakes System in accordance with the research requirements of Annexes 2, 11, 12, and 13;
- c) Determine the physical and transformational processes affecting the delivery of pollutants by tributaries to the Great Lakes in accordance with Annexes 2,11,12,13;
- d) Determine cause-effect inter-relationships of productivity and ecotoxicity, and identify future research needs in accordance with Annexes 11, 12, 13 and 15;
- e) Determine the relationship of contaminated sediments on ecosystem health, in accordance with the research needs of Annexes 2, 12 and 14;
- f) Determine the pollutant exchanges between the Areas of Concern and the open lakes including cause-effect inter-relationships among nutrients, productivity, sediments, pollutants, biota and ecosystem health, and to develop in-situ chemical, physical and biological remedial options in accordance with Annexes 2, 12,14, and sub-paragraph 1(f) of Annex 3;
- g) Determine the aquatic effects of varying lake levels in relation to pollution sources, particularly respecting the conservation of wetlands and the fate and effects of pollutants in the Great Lakes Basin Ecosystem in accordance with Annexes 2, 11, 12, 13, 15, and 16;
- h) Determine the ecotoxicity and toxicity effects of pollutants in the development of water quality objectives in accordance with Annex 1;
- i) Determine the impact of water quality and the introduction of non-native species on fish and wildlife population and habitats in order to develop feasible options for their recovery, restoration or enhancement in accordance with sub-paragraph 1(a) of Article IV and Annexes 1,2,11 and 12;
- j) Encourage the development of control technologies for treatment of municipal and industrial effluents, atmospheric emissions and the disposal of wastes, including wastes deposited in landfills;

- k) Develop action levels for contamination that incorporate multi-media exposures and the interactive effects of chemicals; and
- l) Develop approaches to population-based studies to determine the long-term, low-level effects of toxic substances on human health.

15 U.S.C. § 1525--COMMERCE AND TRADE--DEPARTMENT OF COMMERCE

“The Secretary of Commerce is authorized, upon the request of any person, firm, organization, or others, public or private, to make special studies on matters within the authority of the Department of Commerce; to prepare from its records special compilations, lists, bulletins, or reports; to perform the functions authorized by section

1152 of this title; and to furnish transcripts or copies of its studies, compilations, and other records; upon the payment of the actual or estimated cost of such special work.”